SELF-CONTROL AS RESPONSE PRODUCED TIME-OUT FROM A STIMULUS ASSOCIATED WITH REINFORCEMENT AND RESPONSE INDEPENDENT SHOCK

An abstract of a thesis by
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The problem: To control escape behavior (self-control) from a stimulus associated with response dependent food and response independent shock.

Procedure: Five rats were trained in operant chambers to press a lever (lever A) for VI 30" food during one stimulus (S_1) and never reinforced during another stimulus (S_2). When responding stabilized a second lever (lever B) was introduced. The function of a response on lever B was to terminate S_1 and produce S_2 for three minutes. All subjects exhibited some S_1 escape behavior. Following stabilization of S_1 escape responses one of four frequencies of response independent shock (VI 15", VI 30", VI 60" or VI 3') was presented during S_1. The number of time-out responses (S_1 escape responses) was recorded for the different shock frequencies.

Findings: All subjects responded to escape from a stimulus associated with response dependent food and response independent shock. In general the number of time-out responses increased as shock frequency increased and with increasing exposure to shock.

Conclusions: Rats will exhibit a response defined as self-control.

Recommendations: It would be recommended that further research: (1) determine the effects of different shock intensities; (2) attempt to assess the aversiveness of VI schedules.

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CHAPTER I

INTRODUCTION

Skinner (1953) has defined the response of self-control as one in which an "organism may make the punished response less probable by altering the variables of which it is a function. Any behavior which succeeds in doing this will automatically be reinforced. We call such behavior self-control." Individuals often attempt to control their behavior when a response has conflicting consequences. The response to be controlled is conflictful because it produces both positive and negative consequences. One exhibits self-control by making a <u>controlling response</u> which affects variables in such a way as to lower the probability of the conflictful <u>controlled response</u>.

The importance of the experimental analysis of human self-control has recently been recognized (Skinner, 1953, 1971; Kanfer, 1970; Rachlin, 1970). However, there is only a small amount of systematic animal experimentation to provide direction and an experimental basis for research in human self-control.

The work of Miller (1959) on conflict behavior can be seen as an attempt to identify factors affecting self-control. Miller's rats oscillated in the runway that led to both reward and punishment. This oscillatory behavior was affected by manipulations in magnitude and frequency of reward and punishment and by deprivation levels. However, the Miller studies do not meet the definition of self-control in that a specific "controlling" response, which lowers the probability of oscillation, is not made available.

Egger and Miller (1960) found that rats pressing a lever that produced both food and shock would escape from conflict by pressing another lever that provided a time-out from the conflict bar. Time-out was a 30 second period during which the conflict bar was non-functional. However, results also suggest that ths subjects may have pressed only to produce stimulus change.

The first study in the operant literature relevant to Skinner's definition of self-control was conducted by Hearst and Sidman (1961). Rats were permitted to escape from a stimulus (S_1) in the presence of which they were concurrently reinforced and punished for pressing lever A. The "controlling" or escape response, pressing lever B, produced a fixed duration time-out from both reinforcement and punishment. Reinforcement was available during S_1 on a variable interval schedule, while shock was presented on a fixed ratio schedule. In a variable interval (VI) schedule the first response after a specific, but variable from reinforcement to reinforcement, period of time is reinforced. In a fixed ratio (FR) schedule a response is reinforced after a fixed number of nonreinforced responses have occurred since the last reinforced response. This permitted subjects to decrease response rate during S_1, resulting in differential effects on reinforcement and shock frequency. The low response rate did not effect the number of reinforcers received on the variable interval schedule, however low response rates resulted in fewer shocks because of the slow completion of the shock ratio requirements. Half the subjects exhibited low rates on lever A during S_1, and the other half reliably exhibited S_1 escape behavior by pressing lever B.

Hearst and Sidman (1961) suggest that a combination of VI reinforcement and VI punishment on lever A would have been more conflictful, therefore resulting in more escape responses, since changes in response rate on lever A would then have equivalent effects on food and shock frequency. However, Radiker (1972) found that VI food and VI shock resulted in half of the subjects remaining in S_1, while the other half escaped into S_2.

Studies by Hearst (1963, 1967) and Hearst and Koresko (1964) used a procedure in which food and shock are delivered independently of any response during S_1. This series of studies is an apparent attempt to control oscillations during conflict as in the Miller (1959) studies. Hearst (1967) manipulated the relative frequency of food and shock by changing the variable interval associated with each. Subjects could either terminate or initiate (oscillate) S_1 by responding. Subjects initiated and terminated S_1 most often at intermediate frequencies of food and shock (e.g., VI 30" food, VI 30" shock) rather than when conditions were either very favorable (e.g. VI 30" food, no shock) or very unfavorable (e.g. VI 30" shock, no food).

Results of the above research indicate that response-contingent reinforcement and punishment can result in escape (Hearst & Sidman, 1961; Radiker, 1972) and that time-contingent reinforcement and punishment can also result in escape (Hearst, 1963, 1967; Hearst & Koresko, 1964). The present study is an attempt to control escape behavior by a combination of response-contingent and time-contingent procedures. In this experiment, food was response dependent (response-contingent) and shock was response independent (time-contingent). During S_1 responses on lever A were reinforced on a variable interval schedule for food. Shocks were delivered during S_1 on a variable interval schedule independent of responses. Shock frequencies were manipulated and the number of escape responses into time-out were recorded.

CHAPTER II

METHOD

Subjects

Six male hooded rats of Long-Evans strain (Blue Spruce) were used as subjects. Rat JN-3 was discarded during preliminary training because of illness. All subjects were experimentally naive and 90-100 days old at the beginning of the experiment. Subjects were maintained at 75-80% of their normal free-feeding weight (projected from growth curves) by the use of 0.45 mg. Noyes pellets during experimental sessions and Purina Laboratory Chow between sessions. Water was continuously available in the home cages.

Apparatus

The operant chamber was constructed of plexiglass lined with sheet aluminum. The chamber's inside dimensions were 29.5 cm. long, 25.5 cm. wide, and 26.0 cm. high. The grid floor was seven 2.0 cm. aluminum bars spaced 1.3 cm. apart. On the front panel were two operanda constructed of 1.0 cm. aluminum 5.0 cm. wide, projecting 2.7 cm. into the chamber. The operanda were spaced 11.2 cm. center-to-center 7.8 cm. above the grid floor. Each operanda had a throw of 2.0 mm. requiring a force of 17 gm. to close a microswitch. Reinforcers were 0.45 mg. Noyes pellets delivered by a Davis Pellet Dispenser (PD-104) into a brass food cup centered between the operanda 2.0 cm. above the floor. The house light was a 28V bulb (Chicago Miniature, CM 313). A 1000 Hz tone (BRS AO-202) was presented through a 6.5 cm. speaker when appropriate. Pulsed DC 0.3 milliamp shocks of 0.4 seconds duration were delivered through a Davis Scrambler (DSI 255) to the grids, walls and operanda. The operant chamber, pellet dispenser, speaker and ventilation fan were enclosed in a sound attenuated plywood chamber. Programming of shocks, food, stimuli, etc. was accomplished by solid-state equipment (BRS, 200 series) located in an adjacent room. Sodeco counters and Gerbrands cumulative recorders provided records of performance.

Procedure

Preliminary Training. During shaping, subjects were reinforced for responses on lever A whenever one stimulus (S_1) was on, and were never reinforced when another stimulus (S_2) was on. Lever B was not present in this phase of the experiment. For subjects JN-1 and JN-2, S_1 was a 1000 Hz tone and S_2 a period of silence. JN-4, JN-5 and JN-6 had silence as S_1 and the 1000 Hz tone as S_2. After shaping, subjects were reinforced on a variable interval (VI) schedule for responses on lever A during S_1 and were never reinforced during S_2. Three minute S_1 periods alternated with three minute S_2 periods, with each session beginning in S_1. The VI schedule in effect during S_1 had a mean interval of 30 seconds (VI 30"), with 12 intervals ranging from near zero to 60 seconds in an arithmetic progression of 5 seconds. The VI tape ran continuously throughout the experiment; however, reinforcers were only set up during S_1, i.e. holes in the VI tape were not registered by the programming equipment during S_2.

Preliminary training was completed when 90% of all responses reliably occurred during S_1. The total time each subject spent in preliminary training was between 60 and 70 hours. Experimental sessions were conducted one hour per day, seven days per week, throughout all phases of the experiment.

Time-Out Baseline. In the first session following preliminary training, the second operandum (lever B) was introduced into the operant chamber. The function of a response on lever B was to terminate S_1 and produce S_2 for three minutes. The first response on lever B terminated S_1. During S_2 all responses on either lever A or lever B had no consequences. S_2 periods constituted time-out from food availability. Each session began with S_1 and time-out (S_2) occurred only as a result of lever B responses. If a subject never responded on lever B, S_1 remained on during the entire session.

The response dependent VI 30" food schedule of preliminary training remained in effect during S_1. The number of time-out responses (S_1 escape responses) was recorded for each one hour session. The number of lever B non-escape responses (responses during S_2) was also recorded. The maximum number of 3 minute time-out responses possible in one hour was 20. This time-out baseline remained in effect until the operant level of S_1 escape responses stabilized (10-20 sessions).

Escape (Self-Control) Testing. Escape testing was initiated following stabilization of the time-out baseline. This phase was identical to the time-out baseline, except that response independent shocks were delivered on a variable interval schedule during S_1. Thus the contingencies during S_1 were: (1) occasional response contingent food, VI 30", (2) occasional time contingent shocks, VI 15", VI 30", VI 60", or VI 3'.

The number of S_1 escape responses was recorded at four shock frequencies: 4/min., 2/min., 1/min., and .33/min. (VI 15", VI 30", VI 60", and VI 3' respectively). After S_1 escape responding stabilized at each frequency, either a different shock frequency or a return to the baseline condition of no shock was programmed. Subjects received the different shock frequencies in mixed orders. Specific differences in procedure between subjects are discussed in the context of individual results.

Food and shock tapes ran continuously, but did not set the programming equipment during S_2. The programming equipment therefore only registered holes in the tapes during S_1. Food was always response contingent on a VI 30" schedule, the different frequencies of shock were always delivered independent of the subject's behavior at 0.3 milliamps for 0.4 seconds. An effort was made to prevent manually accidental pairings of a response with shock.

CHAPTER III

RESULTS

All five subjects clearly showed the development of S_1 escape behavior. Figures 1, 2, 3, 4, and 5 summarize the specific procedures and results for each subject. The first panel of Figures 1-5 shows the number of time-out periods produced by each subject during the time-out baseline procedure. Since each S_2 was fixed at 3 minutes, the maximum number of time-outs per one hour session was 20. All subjects showed a tendency to escape into S_2, the number of time-outs per session averaging between 3.2 and 8.8 during this baseline phase.

Following completion of the time-out baseline, each subject was exposed to the different frequencies of response independent shock. Figure 1 summarizes the data for subject JN-1. This subject had a very high response rate, 120 responses per min, on lever A during S_1 (Table 1). The number of S_1 escape responses during baseline was the highest of any subject with an average of 8.8 per session. The VI 15" shock frequency that JN-1 was first exposed to, resulted in a mean of 19.9 timeouts per session. This frequency virtually eliminated all responding on lever A during S_1 and during S_2, with the subject only pressing lever A an average of 15 times per session.

TABLE 1

AVERAGE RESPONSES PER MINUTE

SUBJECT	SHOCK FREQUENCY				
	0	VI 15''	VI 30''	VI 60''	VI 3'
JN-1	(1) 120 (3) 120 (5) 130 (7) 135	(2) 0		(4) 0	(6) 0 (8) 0
JN-2	(1) 30 (3) 15 (6) 20	(5) 0	(2) 0	(4) 0	(7) 0
JN-4	(1) 30 (3) 65 (5) 65	(2) 0			(4) 0 (6) 10
JN-5	(1) 65 (4) 80	(3) 40	(2) 45 (5) 60		
JN-6	(1) 50 (3) 50 (5) 50 (8) 50		(2) 0 (7) 0	(4) 0	(6) 20 (9) 50

Note.--All rates are to the nearest five responses per minute. The numbers in parentheses indicate the order of the different experimental procedures.

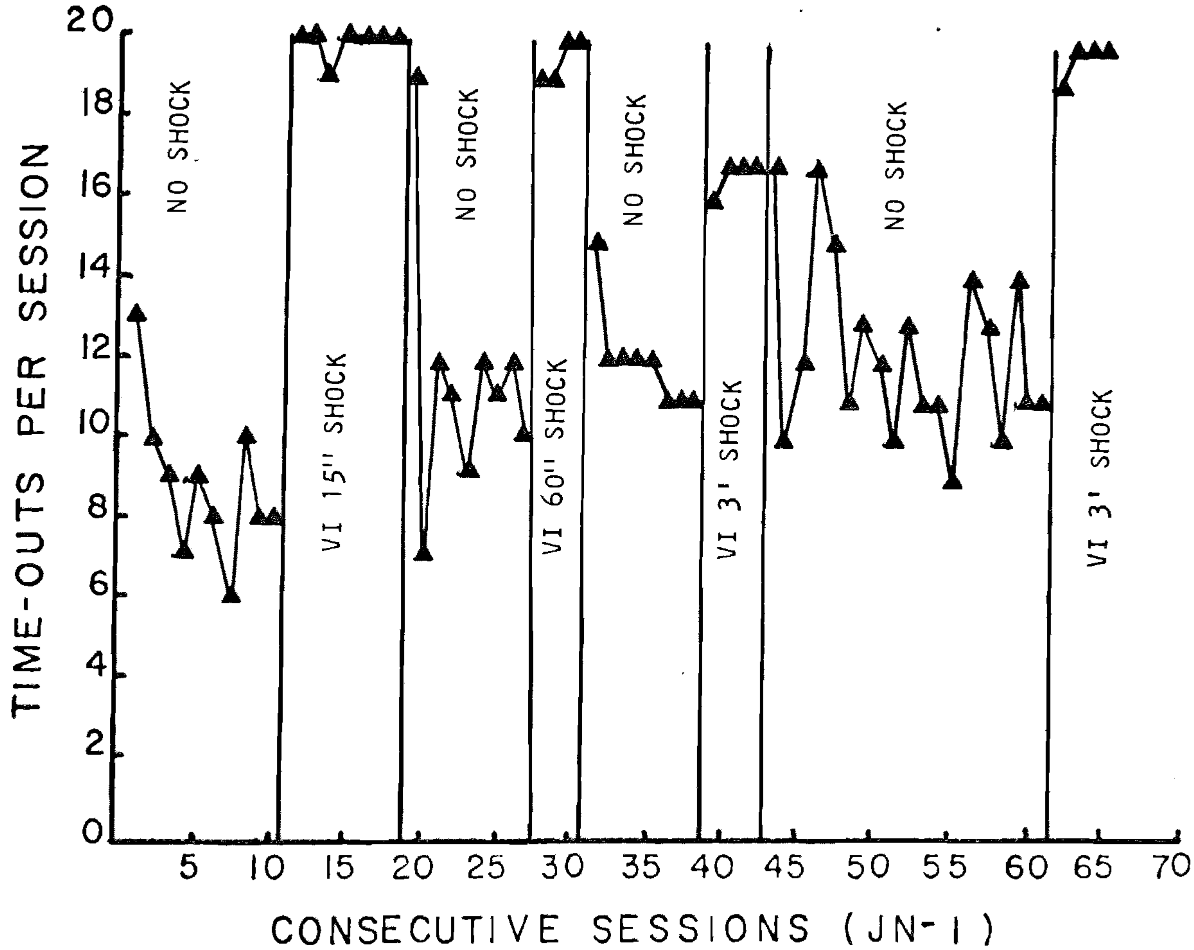

FIG. 1. Number of time outs per session produced by Rat JN-1 under the different experimental procedures. All conditions are for lever A with VI 30" food.

On the third day after JN-1 was returned to baseline, S_1 response rates increased to 165/min, and then declined to previous baseline rates on subsequent days. The number of time-outs stabilized (last 5 days, x = 10.8) at a higher level than in the initial baseline.

The VI 60" shock condition also resulted in near complete lever A response suppression and a mean of 19.5 timeouts per session. After return to baseline, lever A rates during S_1, again exceeded normal rates and then stabilized. The number of baseline time-outs also stabilized at higher levels than previous baseline conditions. During the VI 3' shock condition, the subject made an average of 16.7 time-out responses. S_1 response rates on lever A were high (80/min) for the first two days, then declined to medium levels (45/min). Following the VI 3' shock condition an 18 session baseline condition resulted in an average of 12.5 time-outs per session. Return to the VI 3' shock condition resulted in an average of 19.7 time-outs per session with almost complete suppression of lever A responding during S_1.

Baseline for JN-2 (Figure 2) averaged 3.5 time-outs per session, with a lever A average response rate of 30/min (Table 1). When the VI 30" shock component was initiated, responding on lever A was almost totally suppressed during S_1 and S_2. Time-outs averaged 14.9 per session during VI 30" shock. Return to the no shock condition resulted in an average of 3.5 time-outs per session. S_1 responding on

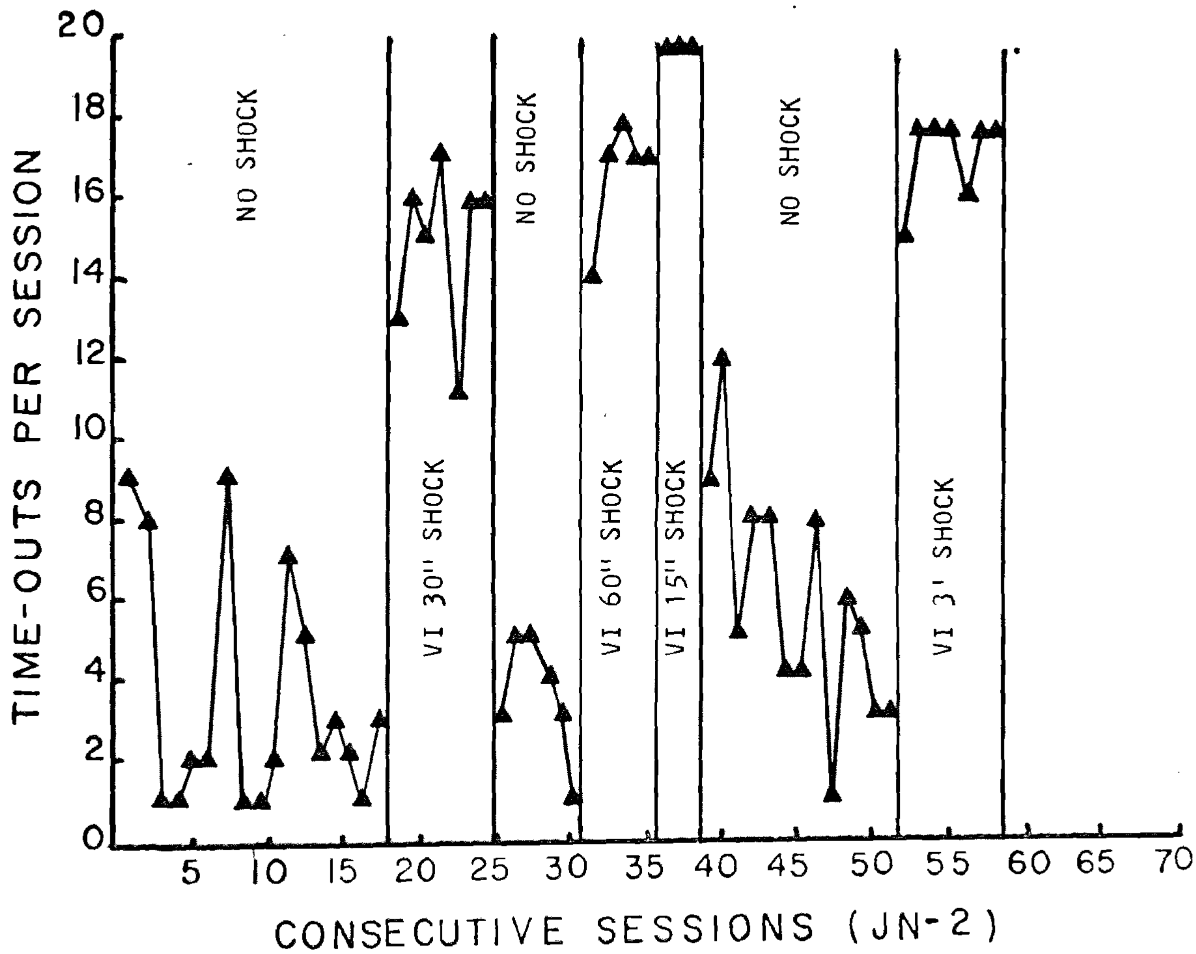

FIG. 2. Number of time outs per session produced by Rat JN-2 under the different experimental procedures. All conditions are for lever A with VI 30" food.

lever A remained at low levels, 15/min, during return to baseline. VI 60" shock resulted in an average of 16.6 time-outs per session and S_1 responses on lever A were suppressed to near zero levels. When the shock frequency was increased to VI 15", JN-2 made 20 time-out responses per session. VI 15" shock completely suppressed lever A responses per session: no responses were made on lever A after the first day of this condition. Return to baseline resulted in a steadily declining number of time-outs. The VI 3' shock condition resulted in an average of 17.3 time-outs per session. Except for the maximum of 20 time-outs per session during VI 15" shock, each shock condition that JN-2 was exposed to resulted in an increase in time-outs even though shock frequency decreased.

The baseline time-outs for JN-4 (Figure 3) averaged 3.2, with an average S_1 rate of 30/min (Table 1). On initiation of VI 15" shock, response rates on lever A declined to near zero levels with between 5 and 30 responses during S_1. This subject spent almost all of each session in S_2, with an average of 19.4 time-outs per session. Return to baseline resulted in S_1 rates on lever A that were much higher than rates before VI 15" shock. After increasing to 120/min, S_1 rates stabilized at 60/min. The number of time-out responses decreased slowly and stabilized at 7 per session, a much higher number than the pre-shock baseline of 3.2 per session. VI 3' shock resulted in an average of 16.4 time-

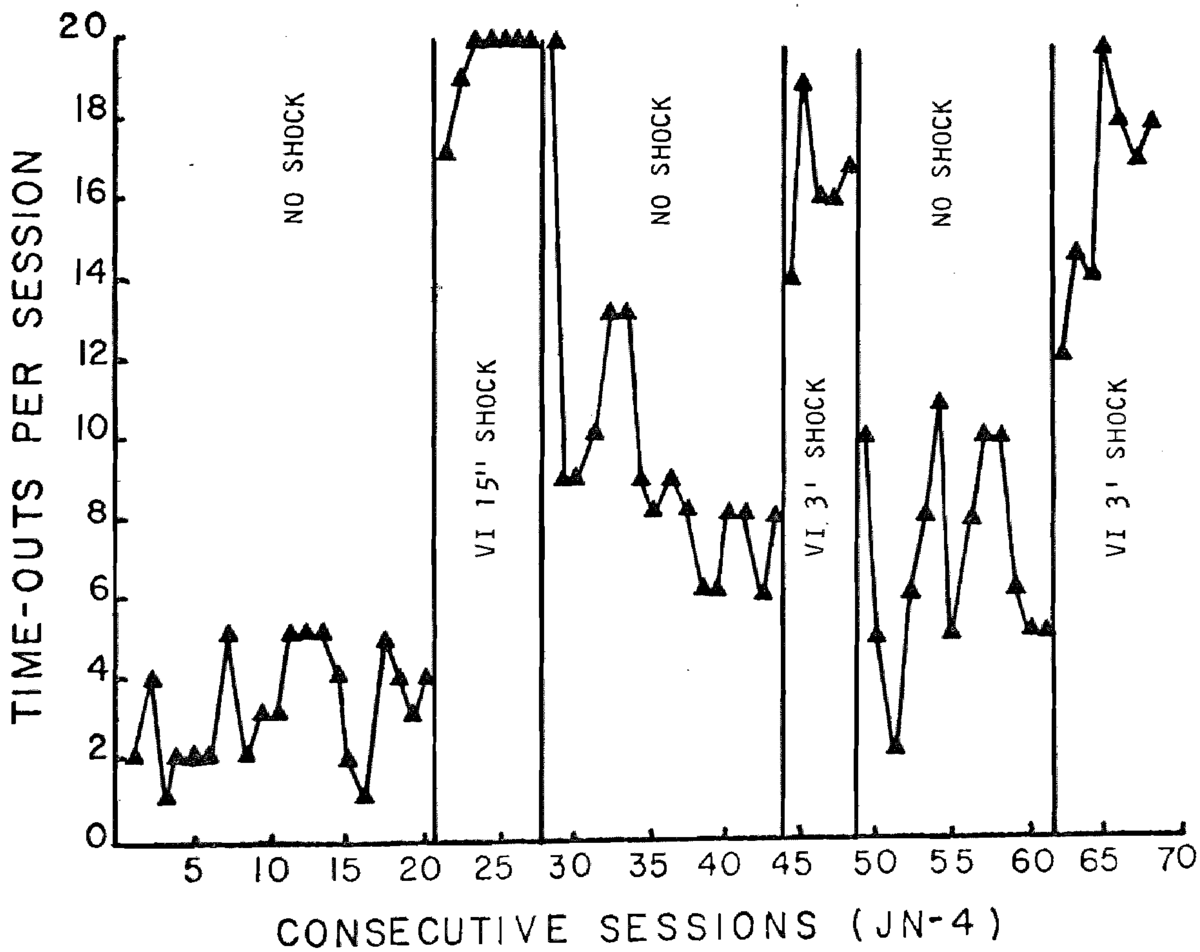

FIG. 3. Number of time outs per session produced by Rat JN-4 under the different experimental procedures. All conditions are for lever A with VI 30" food.

outs per session, while S_1 rates quickly decreased to near zero levels. Return to baseline conditions resulted in an average of 7.0 time-outs per session. Reestablishment of the VI 3' shock condition resulted in an increase to 20 time-outs on the fourth day followed by a decrease. Lever A rates during S_1 remained at near zero levels until the sixth day when JN-4 responded at a rate of 34/min.

Baseline response rates during S_1 for JN-5 (Table 1) were about 65/min, and the baseline level of time-outs stabilized at 4 per session (Figure 4). VI 30" shock reduced the S_1 rate to an average of 47/min. This subject did not suppress responding to the degree that all other subjects did. JN-5 responded at a rate during S_1 that enabled him to receive 95% of the possible food reinforcers. Time-out responses ranged from 5 to 11 per session, with an average of 7.4 per session. When shock frequency was increased to VI 15", this subject continued to respond at a rate of 40/min on lever A. However after three sessions of VI 15" shock the number of time-outs increased from 12 to 20, therefore, the rate of 40/min was only maintained for less than 3 minutes during the last 3 sessions. The return to baseline was long and erratic, with the number of time-out responses ranging from 3 to 11 per session. S_1 response rate recovered to 80/min on the first day after shock, and remained at that level throughout this baseline phase. The second exposure to the VI 30" shock condition resulted in an average of 16.0

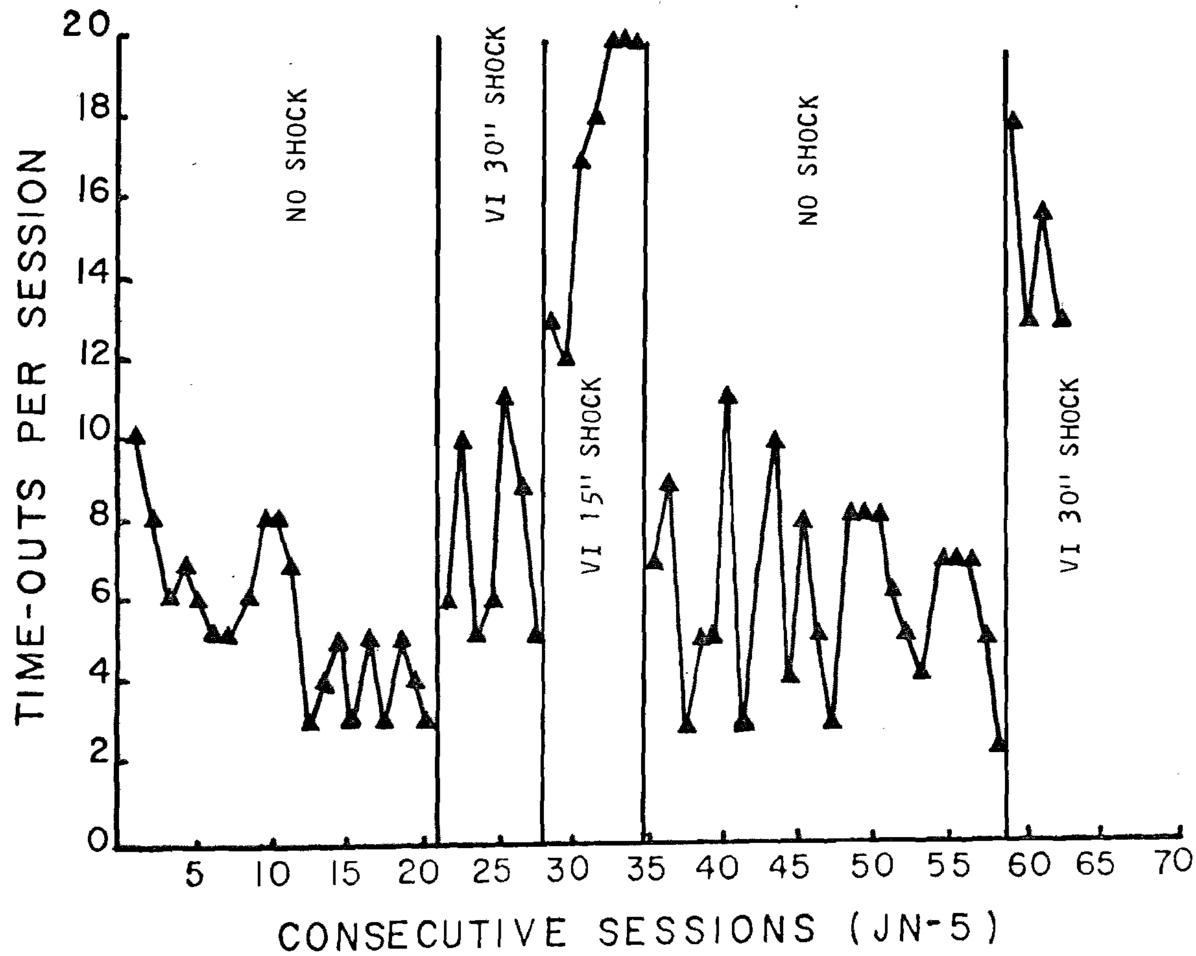

FIG. 4. Number of time outs per session produced by Rat JN-5 under the different experimental procedures. All conditions are for lever A with VI 30" food.

time-outs per session with an average lever A response rate of 58/min during S_1.

The operant level of time-out responses for JN-6 (Figure 5) was 7.6 per session, with a S_1 response rate of 52/min (Table 1). VI 30" shock resulted in almost complete suppression of S_1 responding. The number of time-out responses increased steadily from 15 to 19 after 8 sessions, with an average of 17.6 per session. Return to baseline resulted in a lower number of time-out responses, 5.5 per session, than in pre-shock baseline. Lever A response rates returned to the same stable rates as in the initial baseline. The next shock frequency that JN-6 was exposed to, VI 60", resulted in the maximum time-outs (20) and complete lever A response suppression. Baseline levels of time-out and lever A responding were quickly recovered. This subject did respond at 22/min during S_1 when the VI 3' condition was imposed and the number of time-outs stabilized at 15.5 per session. Increasing the shock frequency to VI 30" completely suppressed lever A responses and the subject made 20 time-out responses during each session. On return to baseline the number of time-outs averaged 5.8/session. The second exposure to VI 3' shock resulted in an increase of the average number of time-outs to 17.5/session. Lever A response rates during S_1 remained at 50/min.

Every subject also responded on lever B during S_2 after the initial time-out response was made (Figure 6).

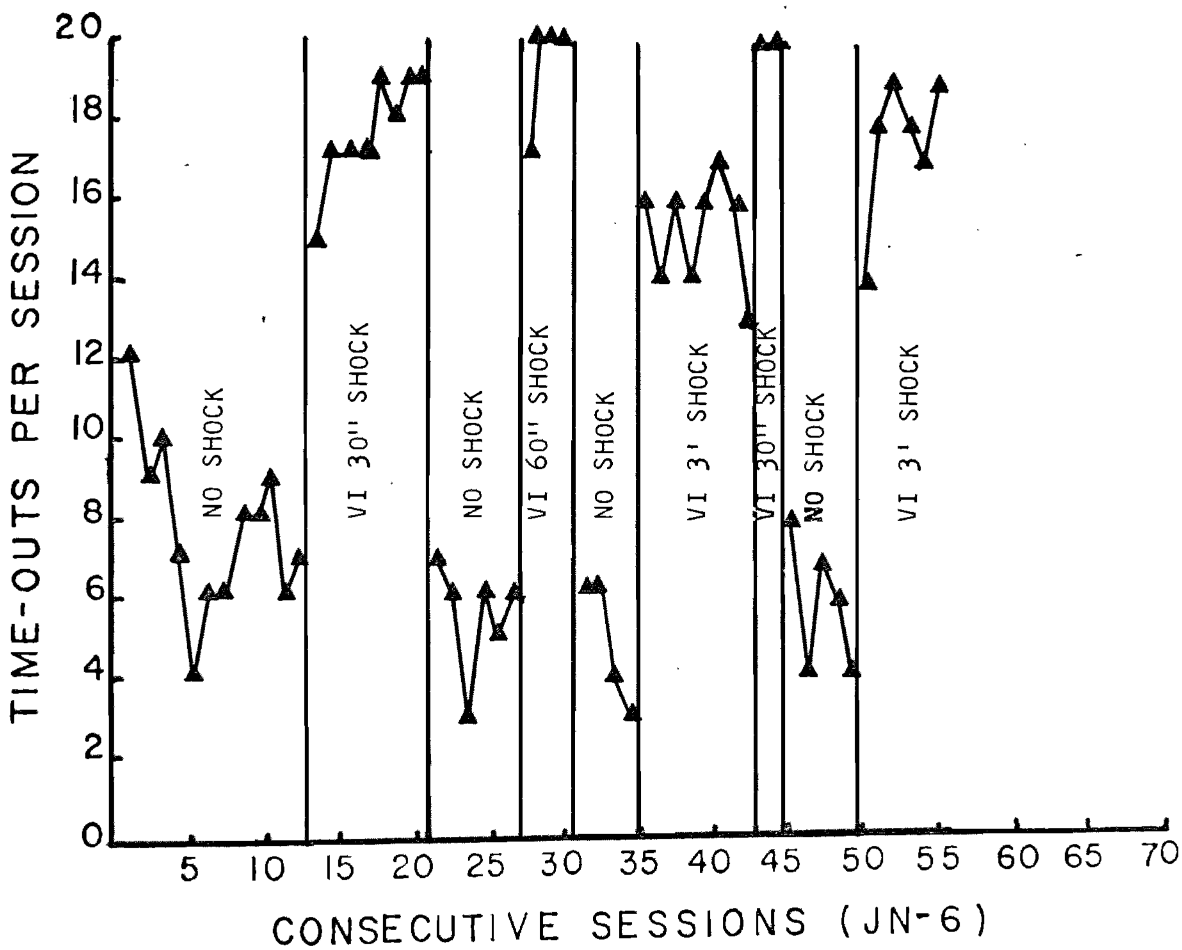

FIG. 5. Number of time outs per session produced by Rat JN-6 under the different experimental procedures. All conditions are for lever A with VI 30" food.

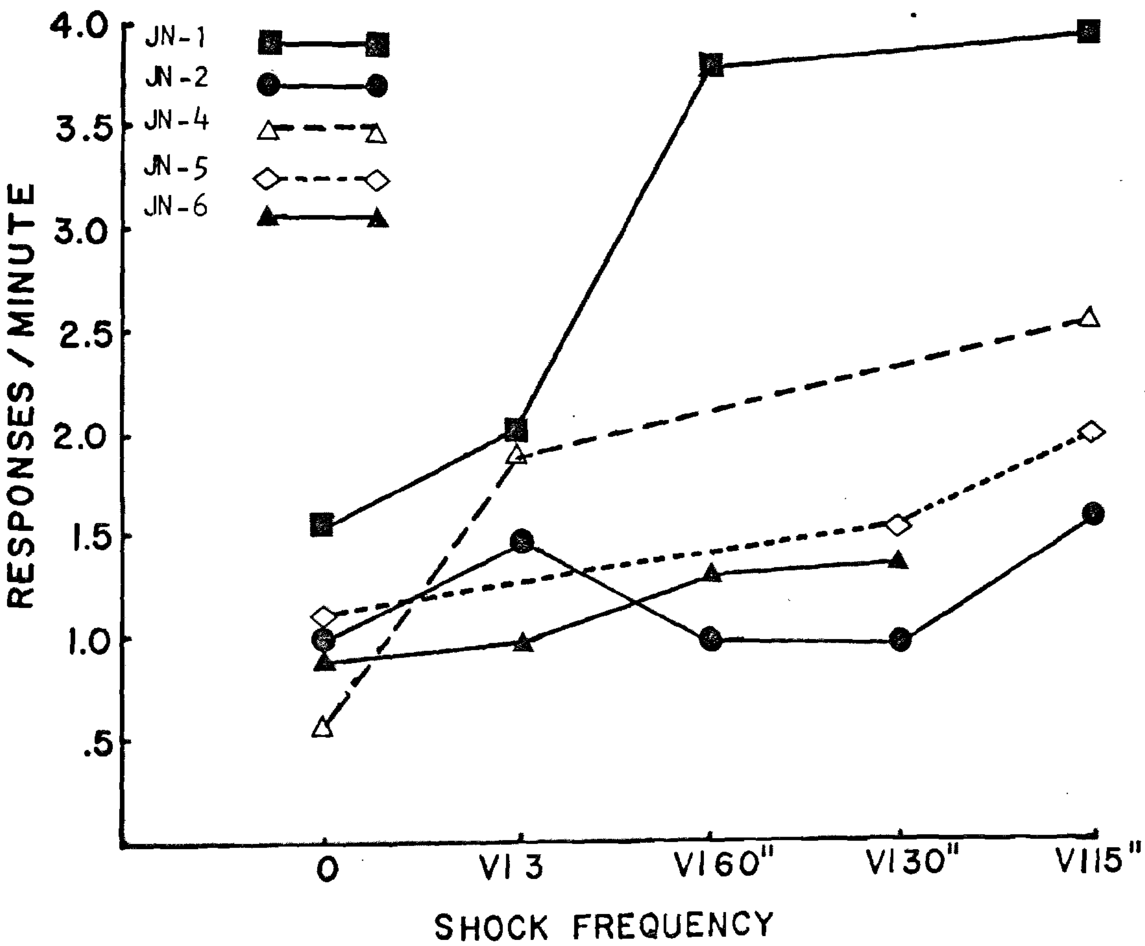

FIG. 6. Average response rate on lever B during S_2 for each subject under the different shock frequencies.

Response rates on lever B ranged from 0.5 to 4.0 per minute during S_2. Response rates on lever B varied with the shock schedule in effect. For all subjects, except JN-2, increasing shock frequencies resulted in increasing lever B response rates. These rates always returned to low baseline rates when shock was no longer in effect.

CHAPTER IV

DISCUSSION

All five subjects reliably emitted responses which enabled them to escape from a stimulus associated with response dependent VI food and response independent VI shock. Lever A responding during S_1 was almost completely suppressed in all shock conditions except VI 3' shock. JN-5 was the only subject that did not suppress lever A responding during S_1 at high shock frequencies.

The high numbers of time-out responses during the initial baseline may be indications of schedule induced escape similar to that observed in fixed-ratio (Azrin, 1961) and fixed-interval (Brown & Flory, 1972) schedules. Observation of the cumulative records of all subjects indicated that most of the S_1 escape responses occurred during the longer intervals. This would support Azrin's (1961) position that organisms escape a stimulus correlated with an intermittant schedule of reinforcement because the stimulus is paired with relatively long periods of nonreinforced responding. Four of the five subjects did not return to initial baseline levels of time-out responses after exposure to the shock procedures. Each baseline phase stabilized at a higher number of time-out responses than in the previous baseline. This may indicate the increasing aversiveness of S_1, even as shock frequencies decreased for some subjects.

In general, the number of time-out responses increased as shock frequency increased, with VI 15" shock producing the most time-outs and VI 3' shock the least. However, these conclusions are confounded by indications that continued exposure to shock results in an increasing number of time-out responses, even if the shock frequency is decreased. All subjects emitted more time-out responses, except if the maximum possible had already been reached, on the second exposure to a particular shock frequency.

The relatively low shock intensity, 0.3 ma., does not by itself account for the high levels of time-out production or for the almost complete suppression of responding on lever A. In a previous study (Filby & Appel, 1966) of response dependent VI shock during VI food, complete response suppression did not occur until the shock intensity reached 0.6 ma.

The high level of time-out responses and the nearly complete lever A response suppression may be the result of the availability of the escape response as observed by Azrin, Hake, Holz, and Hutchinson (1965). The contingencies differed in that punishment was continuous and the escape period provided the opportunity for reinforced responses. Azrin, et al., observed that an intensity of punishment which resulted in little or no suppression in a procedure in which there was no opportunity to escape, produced complete suppression when escape was possible.

The possibility that S_1 escape responses were the result of responding for stimulus change (Egger & Miller, 1960) was not controlled for in the present experiment. However, the almost complete suppression of lever A responding during S_1, the increasing number of escape responses during successive baseline phases and the increase in escape responses on the second exposure to a particular shock frequency are all indications that this procedure results in S_1 becoming a conditioned aversive stimulus. The time-contingent pairing of a stimulus with shock can result in the stimulus becoming a conditioned aversive stimulus which will suppress positively reinforced responding (Estes & Skinner, 1941). An organism will also escape from a conditioned aversive stimulus (Brown & Jacobs, 1949).

Hearst and Sidman (1961) found that if both food and shock are response-contingent escape can result. Later studies (Hearst, 1963, 1967; Hearst & Koresko, 1964) indicate that escape can also occur if both food and shock are time-contingent. Under the conditions of the present study rats will escape from a stimulus during which food is response-contingent and shock is time-contingent.

The relationship of the present study to human "self-control" is exemplified by the situation in which a person attempts to quit smoking. The reinforcing effects of smoking are contingent upon inhaling, however the aversive effects are not contingent with inhaling. The response of inhaling is not explicitly contingent with health problems; cancer occurs years later. As a result the sight, smell and taste of a cigarette do not become conditioned aversive stimuli. Possible procedures that may result in cigarettes becoming aversive include pairing smoking with aversive thoughts (Homme & Tosti, 1971) or with electric shock (Azrin & Powell, 1968). If the stimuli from cigarettes become aversive, then the probability of the "self-control" response (escape from cigarettes or quitting smoking) will increase.

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